



Massive hemoptysis from pulmonary histoplasmosis requiring emergency lung resection and extracorporeal membrane oxygenation

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1. Introduction

Massive hemoptysis is defined as the life-threatening bleeding threshold of 100–1000 mL in a 24-h period or an amount greater than 8 mL/kg every 24 h. Although there is no accepted definition, a diagnosis of massive hemoptysis is made when it results in respiratory and hemodynamic compromise [1]. It is a rare occurrence in childhood with various known etiologies. Common diagnoses in pediatric patients include infection, foreign body aspiration, trauma, tracheostomy-related issues, or cystic fibrosis. The most common cause of hemoptysis involves infectious processes, which may include pneumonia, tuberculosis, and parasitic or fungal infections [2–4]. A retrospective review conducted by Simon et al. reported that 40% of pediatric hemoptysis cases identified infectious processes as the most common cause [5]. A separate retrospective review found that infection was the main causative factor amongst pediatric cases, and, more specifically, congenital heart disease and infection were the leading causes in the adolescent population [6]. (see Figs. 1 and 2)

Frequently utilized diagnostic modalities for hemoptysis include chest radiograph, computed tomography, culture studies, and bronchoscopy. A review conducted at Children's Memorial Hospital in Chicago found that the diagnostic yield for chest radiography was 53% for this patient sample [1]. Approximately one third of pediatric patients with hemoptysis are known to have normal chest radiographs [6]. While chest X-ray is the first line of investigation in patients with hemoptysis, further investigation with CT and bronchoscopy may be necessary if no lesion is identified [7]. The review from Children's Memorial Hospital also stated that when utilizing bronchoscopy to diagnose the cause of hemoptysis, the correct etiology was determined in 61% of patients [2].

Initial management of massive hemoptysis consists of respiratory and circulatory support with mechanical intubation and replacement of fluids and/or blood products. Bronchoscopy and bronchial artery embolization and some measures to control bleeding that does not respond to conservative measures. Surgery with lung resection is a last resort. ECMO to provide respiratory and hemodynamic support has been very rarely utilized in these patients (and probably under-utilized). We present a case where a combination of emergent surgery and initiation

of ECMO were required to stabilize a patient with massive hemoptysis.

2. Case report

The patient is a 15-year-old, 100 kg male, with a past medical history of atrial septal defect, ventricular septal defect and pulmonary artery valve atresia repair shortly after birth. On the day of admission, his parents reported he began choking on some ice and experienced sudden massive hemoptysis. He was intubated at an outside institution but had bleeding out of the ETT. Upsizing of ETT was unsuccessful and so was an attempted tracheostomy. He was successfully orotracheally intubated prior to transfer after a significant hypoxic time.

Upon transfer to our institution, the patient was started on an epinephrine drip and stabilized on the ventilator. A CBC revealed a WBC of 28.5 k/cumm, hemoglobin 10.6 GM/dL and platelets 232 k/cumm, while a chest x-ray demonstrated scattered patchy airspace opacities with left apical and right basilar predominance compatible with infection or edema. Approximately 17–19 mmHg of PEEP was required to tamponade bleeding, and he required peak inspiratory pressures more than 40 mm Hg to maintain adequate tidal volumes. Once he was clinically stable on the second hospital day, a CT angiography of the chest was performed, demonstrating complete obstruction of the bronchus intermedius with atelectasis of the posterior basal segment of the right lower lobe. It was also suggestive of a foreign body in the right lower lobe. No contrast blush consistent with bleeding was noted. Initially, embolization of bleeding vessels was considered, however it was felt to likely be unsuccessful given the concern on CT for a foreign body and no active hemorrhage at that time.

On day 3 of admission he went to the OR for a thoracotomy with planned lobectomy to control the bleeding airways. During that procedure, he required emergent partial right middle and lower lobectomies due to severe hypoxia secondary to sudden and severe hemorrhage through the ETT. The right lower and middle lobes were taken emergently with a TIA stapler in a damage control fashion. An ECMO circuit was kept on standby from the outset of the operation, and when the patient developed persistent hypoxia, the decision was made to cannulate for ECMO. After the thoracotomy was quickly closed with a temporary dressing, ECMO was initiated by inserting a 28Fr double

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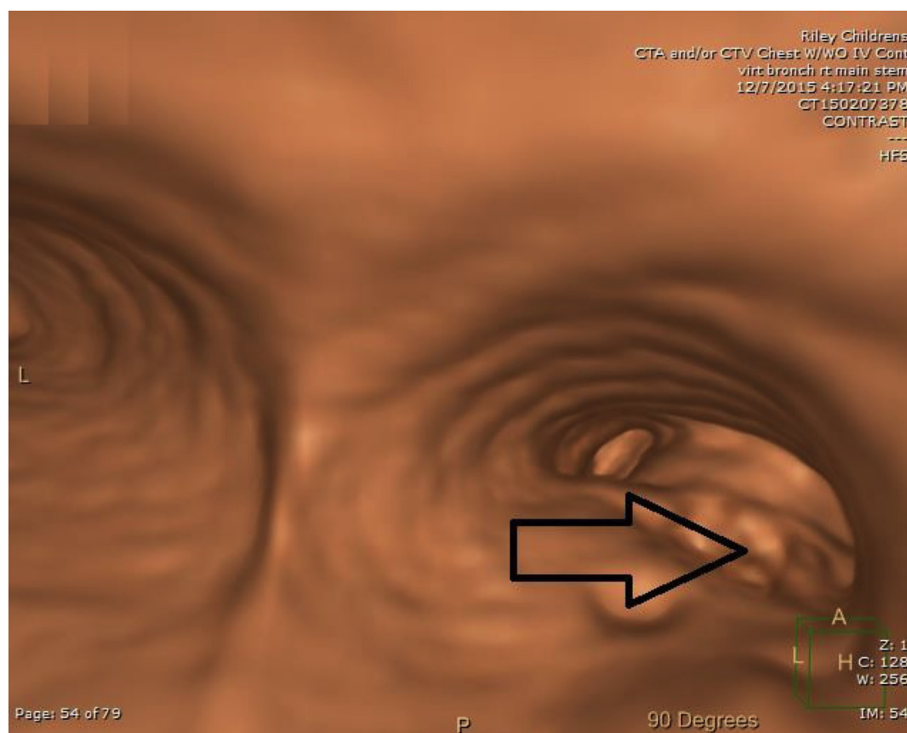


Fig. 1. CT virtual bronchoscopy showing obstruction of right middle lobe and lower bronchi.

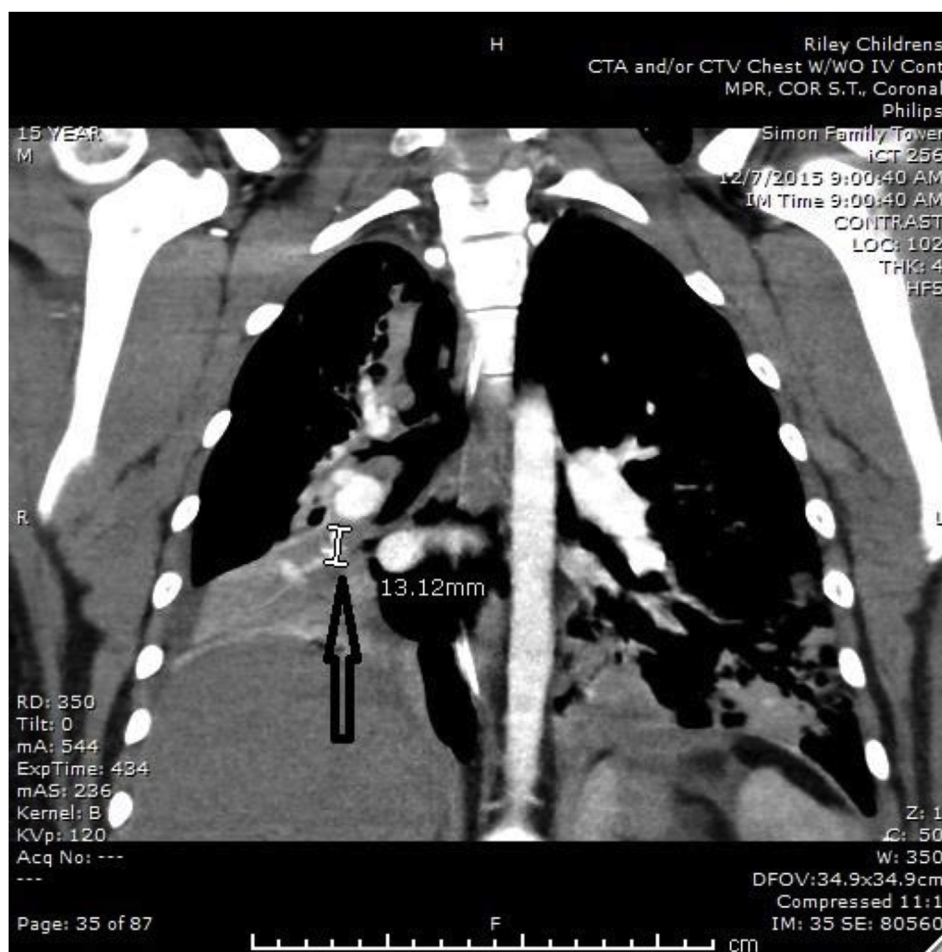


Fig. 2. CT chest showing calcified granuloma in the right lung.

lumen OriGen (OriGen Biomedical, Austin, TX) cannula in the right internal jugular vein and a 23Fr single lumen cannula in the right femoral vein (VV–V ECMO). These sizes were based on our reference cannulation size charts. Both cannulas were placed percutaneously using ultrasound guidance. The patient experienced cardiac arrest just before ECMO was started but regained spontaneous circulation while the ECMO flow was slowly increased. After the patient was stabilized, a bronchoscopy was performed where blood clots including “granuloma”-like material were cleared from the airways.

He remained on ECMO for 5 days. He was maintained on an institutional high risk bleeding protocol with low heparin doses and goal *anti-Xa* levels of 0.3–0.7 IU/mL. Good flows were maintained on ECMO (4.3–4.5 L/min) with a target peripheral oxygen saturation of 85–88%. The patient was maintained on APRV ventilation during his time on ECMO. ECMO was eventually discontinued on post-operative day (POD) 4. During his time on ECMO he required redo chest explorations and washouts with control of bleeding at the bedside on 3 separate occasions. Pulmonology was consulted on POD 2, and a bedside bronchoscopy revealed clots in the left mainstem bronchus, which were suction cleared. The right mainstem was also filled with clots without active bleeding, but these clots were not able to be cleared.

After discontinuing chemical paralysis and ECMO decannulation, the patient had a smaller volume episode of hemoptysis. A flexible bronchoscopy showed a clot in the right mainstem bronchus. A repeat CT chest showed the areas of potential bleeding were the remnant middle and lower lobes. This led to a return to the operating room for completion of the right middle and lower lobectomies. This operation proceeded without complications. Pathology of the lung samples showed massive multiple necrotizing granulomas with microorganisms whose morphology was most consistent with *Histoplasma capsulatum*. Acid fast bacilli stains were negative. The patient was started on amphotericin B on day 6 of his hospitalization and was switched over to itraconazole on day 11. However, pathology was more consistent with an old infection (due to calcified granulomas), and urinary and blood serology were negative for histoplasmosis. Also, the lesions were completely resected. Antifungals were thus stopped on day 13 of hospitalization.

Our patient improved from the respiratory standpoint and was tolerating CPAP trials in 2 weeks. He was extubated on the fourth week of his hospital stay. His neurological exam remained unchanged during this course, as the patient did not initially respond to pain or commands and continued to have purposeless movements. An EEG demonstrated severe encephalopathy with areas that could precipitate focal and secondary generalized seizures. He was discharged to inpatient rehabilitation. He slowly convalesced and, by the time of discharge, was awake and participating in therapy.

3. Discussion

Histoplasma capsulatum is a fungus present in soil, caves, and older buildings and is endemic in the Ohio River Valley. Although often asymptomatic, it may present with flu-like symptoms, making it difficult to diagnose. Histoplasmosis-specific IgG antibodies may stay elevated for months or years after infection. There are few recorded incidences of sudden massive hemoptysis secondary to histoplasmosis. Sheikh et al. described a case of an 11-year-old boy who presented with moderate hemoptysis and a 2-week history of upper airway congestion without fever. A chest CT revealed small, calcified nodules with infiltrates involving the right upper and lower lobes. Additionally, a rigid bronchoscopy revealed normal upper airways but bleeding was noted in the right upper and lower lobes. Bronchoalveolar lavage resulted in negative cultures for bacteria and negative stains for fungal infection. After a selective right bronchial artery embolization using gelfoam slurry the patient had no more hemoptysis and was discharged. Of note, the authors suspected histoplasmosis as a causative agent for the hemoptysis due to the CT scan results, which could indicate that the

patient may have lost his antibody titers over time [8].

Shafer et al. reported a case of a 7-year-old boy who presented with recurrent hemoptysis. Initially, his chest radiograph, physical examination, and CBC appeared normal. On the 5th day a chest radiograph was again performed and showed a patchy right middle and right lower lobe infiltrate. His course of treatment included a bronchoscopy to localize the bleeding followed by an emergent right lower lobectomy. Pathologic diagnosis of the specimen was most consistent with *Histoplasma capsulatum* [9].

Histoplasma granuloma induced massive hemoptysis and hypoxemia is an exceedingly rare indication for ECMO [10]. Utilizing ECMO in patients with infections such as fungemia or bacteremia is generally contraindicated due to concerns for circuit contamination. Our patient had not been found to have *Histoplasma capsulatum* at the time of cannulation, and there was no evidence that he had fungemia from surveillance blood cultures. Also, there was no evidence of active infection in the lungs.

There have been several case reports of patients of all ages being treated with ECMO as a rescue therapy for respiratory compromise resulting from massive hemoptysis. Total respiratory bypass allows clamping of the endotracheal tube with subsequent tamponade of bleeding, thus potentially avoiding emergent surgical therapy in these patients. The use of ECMO can also permit better pulmonary toilet to clear the obstructing debris and clots, providing full support without the worry of hypoxia from breaking into the ventilator circuit [11–17]. Fortunately, the use of anticoagulants with ECMO has not been shown to worsen patient outcomes in these cases. However, if possible, limiting or holding anticoagulation altogether is recommended. The use of anticoagulation in such patients remains a special concern as clinicians have to balance clotting of circuit with worsening of pulmonary hemorrhage. Low dose heparin with strict control of ACT, Anti Xa, and antithrombin III levels, along with liberal use of platelets and FFP is our preferred method to attain this balance. We also employ the antifibrinolytic agents aminocaproic acid and tranexamic acid situationally to limit bleeding in high risk patients. Additionally, nafamostat mesylate has been used for regional circuit anticoagulation in bleeding patients due to its short half life, but is not currently approved by the FDA [15].

In conclusion, we were able to provide full respiratory support to allow for tamponade of the bleeding airways, gradual airway clearance, and gentle alveolar recruitment in a patient with massive hemoptysis due to pulmonary histoplasma infection. This was accomplished by a well-trained multidisciplinary team emergently initiating VV-ECMO in a controlled setting. Thus, VV-ECMO should continue to be considered as an adjunct for emergency airway management. The rare requirement for emergent surgery for hemoptysis along with resuscitatory measures involving ECMO make our case unique in literature.

Patient consent

Not needed.

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Authorship

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Conflicts of interest

All authors declare no conflicts of interest.

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